CHAPTER 890
STORM WATER MANAGEMENT

Topic 891 - General

Index 891.1 - Introduction

The term “storm water management” refers to the cooperative efforts of public agencies and the private sector to mitigate, abate, or reverse the adverse results, both in water quantity and water quality, associated with the altered runoff phenomena that typically accompanies urbanization. Storm water management encompasses a number of control measures, which may be either structural or non-structural (including policy and procedural measures) in nature. The control measures utilized to accomplish the desired goals are often referred to as "best management practices", or BMP's.

The legal necessity to implement the various BMP's is based upon a variety of Federal, State and local regulations that set restrictions on water quantity and quality. Engineers are faced with an increasingly complex task in keeping current with changing regulations and accurately assessing the effectiveness of the BMP's in meeting the objectives of the regulations.

A comprehensive storm water management plan must consider both temporary (construction phase) and permanent controls. See Index 110.2 for general policy. Guidance related to temporary controls can be found in The Caltrans Storm Water Quality Handbook, “Construction Contractors Guide and Specifications”. For information related to the designers responsibilities in implementing storm water quality controls, and permanent control measures in particular, refer to the Caltrans Storm Water Quality Handbook, “Planning and Design Staff Guide”.

For additional information on the subject of storm water management see Volume XII of the AASHTO "Highway Drainage Guidelines, and Transportation Research Board Synthesis No. 174 “Stormwater Management for Transportation Facilities”, 1993.

891.2 Philosophy

A drainage philosophy which has prevailed for years is that surface waters should be intercepted, collected, and disposed of as rapidly as possible. The philosophy continues to be applied but can be considered neither responsive nor adequate in much of today's rapidly developing world. Application of this philosophy has been recognized as a causative factor in a number of runoff related damages to public and private property. Unwise handling of runoff has resulted in downstream flooding, erosion, and discharges of sediment and possibly other pollutants to receiving waters.

Although most damages occur as a result of infrequent to rare runoff events, the need to be sensitive to virtually all actions which modify volumes, times of peak discharge, erosion and sediment transport, and discharge of pollution must be addressed. This is necessary since storm waters cross jurisdictional lines and those jurisdictions must cooperate for the general well-being of the public. The results of poor storm water management may take years to become fully apparent.

Caltrans is responsible for mitigation of runoff impacts resulting from the construction, operation and maintenance of its facilities. When runoff impacts result from a Caltrans project, then the cost of mitigating these impacts is a legitimate part of the project cost. Since transportation funds are increasingly limited, and because mitigation of runoff problems can be expensive, it is important to identify the causative factors and responsible parties. When runoff impacts are caused by others, avenues for assigning these costs to the responsible party should be evaluated. The local agencies responsible for land use in the area are a good place to begin this evaluation, as many of these local agencies have enacted land use regulations in an effort to control flooding. These regulations often require that developers limit changes in the volume and rate of discharge between the pre- and post-development site conditions. In addition, many local agencies must be responsive to their own storm water permits which require that they implement programs to control the quality of storm water discharges within their jurisdiction. When run-off impacts are caused jointly by Caltrans and others, it may be possible to develop cooperativetive agreements allowing joint impact mitigation. See Indexes 803.2 and 803.3 for further discussion on cooperative agreements and up-grading of existing highway drainage facilities.

891.3 Regulations

The enabling legislation for federal storm water management regulations are contained in the 1972 Water Pollution Control Act, and its subsequent amendments. In 1990 the U.S. Environmental Protection Agency (EPA) regulations expanded the National Pollutant Discharge Elimination System (NPDES) to include storm water runoff as a pollutant source requiring permit. These regulations affect how we address the quality of storm water discharges.

In California, the EPA has delegated its authority to issue NPDES permits to the State Water Resources Control Board (SWRCB) and nine Regional Water Quality Control Boards (RWQCB's). The SWRCB issued two general permits; the General Permit for Storm Water Discharges Associated with Construction Activity and the General Permit for Storm Water Discharges Associated with Industrial Activity. The construction general permit applies to all Caltrans construction projects resulting in 2 or more hectares of soil disturbance. The RWQCB’s issued a number of NPDES permits to individual districts: these permits set forth local requirements for the discharge of storm water from Caltrans facilities located in the District. Therefore, each Caltrans district is often responsible not only for complying with the various general permit requirements, but also for negotiating with their respective RWQCB's to limit the local permit requirements to reasonable and practicable levels. The District Hydraulic Engineer, in addition to the Headquarters Environmental Program, should play an active role in reviewing any proposed permitting action and provide input prior to finalization.

Topic 892 - Storm Water Management Strategies

892.1 General

(1) *Expected Water Quality Benefits*. Strategies aimed at managing storm water quality are a relatively recent development. Performance data from full-scale, field applications are few and site climatology and pollutant loadings can have considerable variation and a wide range of impacts on a given strategy. As a result, any discussion of the various storm water management strategies can only give approximate ranges of pollutant removal capabilities.

New technologies or strategies for water quality control are likely to develop which will require the modification of, or make obsolete, strategies that are currently being utilized. On-going monitoring, not only of the direct storm water runoff, but also the effects on receiving waters, humans, vegetation and aquatic life is being conducted to determine the long term cost effectiveness of the structural control measures selected, and any future revisions that might be necessary.

(2) *Water Quality Strategy Implementation*. Storm water treatment controls, unlike source controls, are often high cost items that will require extensive long term maintenance. Any decision to implement one, or more, strategies must consider site constraints, demonstrated need based upon the beneficial uses of the receiving waters, effectiveness of alternative source and treatment control measures, potential for system failure based upon site conditions and pollutant loadings, public/worker safety and availability of maintenance staff to keep the facility in proper working condition.

Implementation of storm water management concepts must also conform to the policies set forth in the Caltrans Storm Water Management Plan. This state-wide plan is being developed in concert with a proposed state-wide NPDES storm water permit and provides a framework within which the Department will address storm water quality issues.

(3) *Quantity / Quality Relationship*. Management of storm water quality often requires the assessment of relatively small runoff producing events. As much as 80 percent of average annual rainfall is produced by storms with return periods of two to six months. As a result, water quality facilities are typically sized to address relatively small runoff volumes. Conversely, storm water quantity management is typically directed at reducing the peak flow rate on storms with a 10-year or greater return period, and water quantity control facilities must be sized accordingly.

In order to achieve both water quantity and quality benefits, it may be necessary to use a combination of strategies or control measures. For example, placement of a relatively small detention basin or filtration immediately upstream of a quantity attenuating detention basin can provide sediment capture, while allowing larger flows to be mitigated by the major basin. Some types of water quality control measures will need to incorporate bypass features so that the smaller, more frequent, runoff events can be treated while still allowing larger flows to be routed away from the traveled way.

892.2 Types of Strategies

There are various storm water management strategies which may be used to mitigate the effects of storm water runoff problems. They vary from very simple to very complex techniques depending upon specific site conditions and regulatory requirements which must be satisfied.

The Caltrans Storm Water Quality Handbook, “Planning and Design Staff Guide” provides both design guidance on specific water quality control measures as well as a more general discussion of how and when to incorporate water quality control measures into projects.

In addition to the measures described in the Storm Water Quality Handbooks, the following measures may provide relief in dealing with the water quantity side of storm water management.

(1) *Detention & Retention Basins*. The detention and retention basin designs provided in the Storm Water Quality Handbooks are based upon water quality control, not quantity control. Refer to the Caltrans training course manual “Storm Water Management Design” for information related to design considerations for peak flood reduction through the use of detention and retention basins.

(2) *Groundwater Recharge*. In some locations highly permeable underground strata may allow percolation of excess runoff into the ground. Benefits include recharge of underground aquifers and the possible reduction or elimination of conveyance systems along with pollutant removal. Special care must be exercised in areas of high groundwater to avoid potential contamination of the aquifer.

(3) *Drainage Easements*. In areas where right of way is inexpensive it may be possible to purchase flood easements. These areas are typically used for agriculture and are subject to flooding at any time during specified times of the year. Cooperative agreements with local agencies or flood control districts will typically be necessary.

892.3 Design Considerations

The items presented below describe some of the issues to be considered prior to, and during, the design of any storm water management facility. General issues common to most storm water management strategies that need to be evaluated are:

- Access for maintenance must be provided, and the facility must be maintainable. Storm water control facilities must not become regarded as wetlands themselves, which would require special permits for routine maintenance.
- Facilities should be designed to “blend in” with their surroundings to the greatest extent possible. The district landscape architecture unit should be contacted for assistance.

- The effects of the proposed facility on channel capacities and existing floodways require evaluation. Care must be taken to evaluate the effects related to the delayed release from detention facilities since an increase in downstream peak discharges may result (see Figure 892.3).
- The effects of releasing sediment free "hungry" water into channels and the potential for increased erosion rates downstream must be determined.
- Evaluate the effects of depriving downstream water users (human, aquatic or vegetative) of runoff due to retention, percolation or other diversion.
- Where pollutant control is necessary, first consider source controls. Source controls are less expensive than treatment controls, and will often negate the need, or help limit the size of treatment control facilities.

See Table 892.3 for a comparative assessment of effectiveness and considerations for various BMP's.

Storm water management techniques involving on-site and off-site storage may offer the highway design engineer the more reasonable and responsive solution to problems relative to the handling of excess runoff. The cooperation of other jurisdictions is generally a prerequisite to applying these strategies and a cooperative agreement is almost always necessary. See Chapter 12 of the AASHTO Model Drainage Manual for additional design criteria for storage facilities.

892.4 Mixing with Other Waste Streams

Storm water runoff from State highways will usually be carried to a receiving body of water without being combined with waste water. Although some combined storm and sanitary sewers do exist, their use should be avoided.

The most common areas of waste stream mixing have been at maintenance stations. These facilities may have combined storm water and wash rack systems. Because of wash water and rinse water, maintenance stations present unique water quality problems from concentrated levels of pollutant loadings. The preferable design has a separate system for the wash rack so that it is not mixed with storm water and rinse water. For additional advice on treatment of concentrated waste streams at maintenance stations, contact the Sanitary Unit in the Office of Structures Design.

Topic 893 - Maintenance Requirements for Storm Water Management Features

893.1 - General

As mentioned previously, the ability and the commitment to maintain storm water management facilities is necessary for their proper operation. The designer must consider the maintenance needs, and the type of maintenance that will take place, in order to provide for adequate access to and within the facility site.

Additionally, the designer should initiate both verbal and written contact with District maintenance to verify the availability of resources to provide proper maintenance and to keep them aware of potential high maintenance items that will be constructed. Initial estimates of how often sediment removal should be performed should be provided by the designer based upon estimated design loadings. Other types of maintenance, such as periodic inspections of embankments, inlet/outlet structures, debris removal, etc. should also be discussed. Due to the large capital investment required for constructing storm water management facilities, proper maintenance cannot be overlooked.

By definition, detained water contributes to runoff and therefore detention ponds or basins must have an outlet and outfall system (see Index 816.4). A gravity outfall should be used whenever feasible. Pumping should only be used where there is no other practical way of handling the excess runoff. See Topic 839 for further discussion on pumping stations.

Table 892.3
Comparative Assesement of Current Urban Best Management Practices

	Infiltration Trenches (PD6)	Infiltration Basins (PD6)	Porous Pavement (PD6)	Retention Basin (PD11A)	Extended Detention Basin (PD11B)	Oil/Water Separators (PD13)
Pollutant Removal Reliability	Presumed moderate	Presumed moderate, if working	High, if working	Moderate to High	Moderate, but not always reliable	Presumed low.
Longevity*	50% failure rate within 5 years	60 - 100% failure within 5 years	75% failure rate within 5 years	20 + years	20 + years, but frequent clogging and short detention common	20+ years
Appropriate Applications	Highly restricted (groundwater, low perc. rate, high sedimentation, slopes will restrict)	Similar to Infiltration Trenches	Extremely restricted. For small, low traffic areas only.	Useful where particulate and dissolved pollutants are of concern	Requires adequate R/W	Maintenance Stations or other small sites
Regional Concerns	Not recommended for areas subject to extended freezing temp's	Freezing climates	Freezing climates	Few	Few	Few
Environmental Concerns	Slight risk of groundwater contamination	Slight risk of groundwater contamination	Possible groundwater impacts	May not be suitable near drinking water wells, septic tanks or drain fields; or if potential for haz. chemical spills exist.	Possible stream warming and habitat destruction	Resuspention of pollutants, Disposal of residual.
Comparative Cost	Low const. cost, but maint. cost is high	Low const. cost, but maint. cost is high	Cost effective compared to conventional asphalt when working properly	Relatively low	Lowest cost alternative for large runoff volumes	Relatively high compared to trenches
Special Considerations	Sediments should be settled prior to infiltration. Depth to bedrock must be adequate.	Not widely recommended unless longevity can be improved	Recommended only with careful construction and effective maintenance.	Must provide bypass for medium to large rainfall events	Must provide maintenance access	Not recommended for "mainline" applications

*Based on current designs and provision of normal maintenance.

Figure 892.3
Example of Cumulative Hydrograph With and Without Detention